Lorentz Force Accelerator Technology Investigated

The NASA Glenn Research Center is developing Lorenz force accelerators (LFAs) for a wide variety of space applications. These range from the precision control of formation-flying spacecraft to the primary propulsion system for very high power interplanetary spacecraft. The specific thruster technologies being addressed are pulsed plasma thrusters (PPT) and magnetoplasmadynamic (MPD) thrusters.

The PPT mounted on the Earth Observing-1 spacecraft was operated successfully in orbit in 2002. The two-axis thruster system is fully incorporated in the attitude determination and control system and is being used to automatically counteract disturbances in the pitch axis of the spacecraft. Since the first successful functionality demonstration, the effects of thruster emissions on communication systems have been examined. X-band communications data packages were transmitted during thruster operation and analyzed for data corruption. The analysis verified that there was no measurable increase in bit error rates during thrus-ter operation. Such benign interactions reduce user concerns and pave the way for electric propulsion appli-cations on future Earth-imaging satellites.

Future applications of pulsed plasma thrusters will include longer life, higher precision, multiaxis thruster configurations for three-axis attitude control systems or high-precision, formation-flying systems. Advanced components, such as a "dry" mica-foil capacitor, a wear-resistant spark plug, and a multichannel power processing unit have been developed under contract with Unison Industries, General Dynamics, and C.U. Aerospace. A life test has demonstrated over 18 million pulses on these components, which approaches the near-term life requirements for deep-space interferometry demonstrator missions. Additional in-house research has included the performance evaluation of additives to polytetrafluoroethylene (PTFE) propellants, which indicated that adding small amounts of carbon to PTFE significantly reduced propellant ablation rates, resulting in a 20- to 50-percent improvement in specific impulse depending on thruster conditions.

High-power, steady-state LFAs are being considered as primary propulsion options for robotic and piloted interplanetary and deep-space missions. Glenn's LFA team is developing megawatt-class MPD thrusters to meet these demanding future mission requirements. MPD system models have been developed, a thruster has been built to parametrically consider new thruster geome-tries, and Glenn's high-power test facility has been utilized to evaluate megawatt-class MPD thruster performance (see the photograph). The initial quasi-steady data demonstrated 35-percent efficiency with argon propellant, with thruster models showing a path to 50-percent efficiency. Future plans include the numerical modeling and design of more efficient thruster geometries and experiments to demonstrate improved efficiency and assess thruster lifetime.

Laboratory magnetoplasmadynamic thruster is prepared for operation.

Find out more about this research:
Earth Observing-1 PPT experiment: http://space-power.grc.nasa.gov/ppo/projects/eo1/
Earth Observing-1: http://eo1.gsfc.nasa.gov

Glenn contact: Eric J. Pencil, 216-977-7463, Eric.J.Pencil@nasa.gov
Authors: Eric J. Pencil, Dr. Michael R. LaPointe, Lynn A. Arrington, Dr. Hani Kamhawi, Scott W. Benson, and W. Andrew Hoskins
Headquarters program offices: OSS, OSF, OAT, OES
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